a conceptual framework for the estimation of opportunity loss at the regional-sectoral level with an application to Greece

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In recent years, the increasing concentration of economic activity in the Greater Athens Region has caused a considerable amount of concern among urban and regional analysts and policy makers.[1] Though some consider international and interregional growth inequalities as a prerequisite to sustained economic growth[2] it is widely accepted that grossly unequal regional growth patterns interfere with national developmental efforts. To formulate appropriate regional economic policy one has to consider current as well as potential levels of economic achievement and explore the etiology behind differences between them.

This paper addresses the problem of measurement of the economic achievement and potential of regions. An attempt is made to formalize some existing concepts in a way that facilitates quantification of a measure of economic development. The methodology that is developed is subsequently used to calculate sectoral opportunity loss in the Greater Athens Region. The reasoning behind this study stems from the belief that policy makers armed with reliable indicators of economic strengths and weaknesses may be in a better position to formulate regional policy. Carr observed that

«... in a very real sense the city is what people think it is. The City that we know personally (the city of the mind) largely determines the world in which we have our life's experience».[3]

What he was alluding to are the images and expectations of spatial phenomena that are formed in one' s mind through experience and that have come to be known as «mental maps». The formation of these images and expectations is applicable not only to cities but to regions as well. When one visits an area for the first time he expects evidence of the presence of some phenomena and absence of others. The mechanism he uses to perceive and cognify spatial phenomena is comparison. He compares the area in question with a real or imaginary prototype. The implications of this process are profound. By accepting a state of affairs one, by necessity, calls attention to deviations from it. In turn, such deviations require explanations which, if obtained, enrich one's experience. This process is model building of the intuitive

1. For an analysis of this problem, see D. J. Plessas, C. Davos, «The Greek Regional Problem: Some Analytic and Policy Perspectives», *The Greek Review of Social Research,* 14, 1972, 163-171. See also N. Georgulas, A. Markopoulou, «Mixed Uses in Athens Urban Area», *Built Environment Quarterly,* March 1977, 73-78.

2. See H. Chenery, «Competitive Advantages and Development Policy», *Amer. Econ. Review,* 51, March 1961, 18-51 and R. Nurkse, *Problems of Capital Formation in Underdeveloped Countries,* Oxford Univ. Press. 1953.

3. S. Carr, «The City of the Mind» in H. M. Proshansky, *et al.* (eds.), *Environmental Psychology,* Holt, Reinhart and Winston, 1967, p. 519.

variety. Since the information in models of this type is vast and the variables many, their use is limited. Still, the presence of unexpected or the absence of expected phenomena in a region challenges the intellect. The presence of an extensive subway system in a rural county, for example, is as peculiar a phenomenon as the absence of newsstands from the downtown of a metropolitan area.

The phenomena cited here are so much a part of daily experience that they cannot be dismissed easily. Even though they can be supplemented with the output from formal models and recent attempts to quantify them have had some success, they leave a lot to be desired in terms of applicability. A more efficient approach might be to attempt fitting a formal model to the processes sketched here. Such a model could never attain the level of generality of the actual processes for the simple reason that only measurable attributes can be included. Perhaps, however, the generality such a model would lack, it would make up in applicability.

The concept of production will be used to explore these processes in a fashion conducive to empirical investigation. Land, capital and labor are the primary factors of production. Labor can be broken down into two distinct components, labor itself or «human activity that provides the goods or services in an economy»[4] and the skills of those involved in the labor force.

Early in the twentieth century, Hall investigated the influence of labor force skills on the concentration of industries at certain locations and on specialization in production. He concluded that sub-national spatial economic systems are controlled by local entrepreneurs and that labor skills contribute to the success or failure of an enterprise quite apart from locational considerations. Chinitz observed discrepancies between the gross national product and the gross product of the regions comprising a nation. He claimed that gross regional product is often less than it should be. According to him, the reason for this discrepancy is the fact that labor skills are neither uniformly distributed over space nor completely mobile. As a result of regional differences in the availability of labor skills, economic opportunities cannot always be exploited profitably. Chinitz argued that studying the distribution of labor at the national level would be misleading because

«...not all opportunities and all entrepreneurs confront each other... in the national market...»[5]

Implicit in his observations is the argument for increased investment in human capital. Economic underdevelopment is usually characterized by outmigration, low levels of investment in education and other services resulting in deterioration of labor skills. In turn, these cause decline in production levels.

A modern spatial economy is characterized by technological and institutional changes affecting production and distribution processes. These changes do not have identical effects in all industrial sectors. Changes are sector-specific regardless of the impact they may later have on other sectors of the economy. These effects are not always favorable. For example, changes aimed at reducing transport costs may alter optimal location patterns by affecting the relationships between sources of raw materials, production centers and markets. As a result, some locations may find themselves favored in terms of a particular activity and others unfavored. In general, economic growth is expected to occur in «favored» locations and decline in «unfavored».

Thus, the conditions that are prerequisite for economic growth or decline derive from institutional or technological changes, namely changes in production or distribution. Both types of changes have high costs in terms of time. Information must reach all involved parties. Additional time elapses between the reception of the information at its destination and action. In relation to these problems, Ratchford observed that

«...economic change frequently develops before it is noticed while group consciousness lingers on long after the economic bases for it have disappeared...»[6]

Therefore, actual economic growth will rarely, if ever, match optimum growth. Similarly, actual growth rates will probably never approach optimal rates. These differences correspond to economic deficiencies.

The concept of opportunity loss addresses economic deficiencies resulting either when an activity is pursued when another activity would have been preferable or when a particular activity is not pursued at all. Opportunity loss can be defined as the difference between the cost or profit realized in pursuing a course of action and the cost or profit which would or could be realized if the optimal course of action had been pursued.

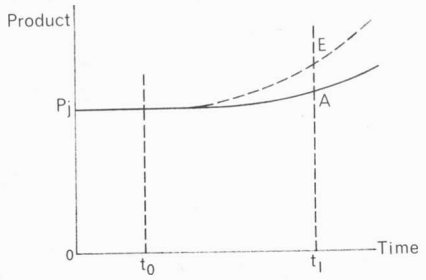
Assume a region i where production of sector j has been relatively stable for some years. At time t_0 an exogenous event generates additional demand for

4. This definition can be found in *Webster's Seventh New Collegiate Dictionary,* 1965, p. 470.

5. B. Chinitz, «Appropriate Goals for Regional Economic Policy», *Urban Studies,* 3 (1), 1966, p. 6.

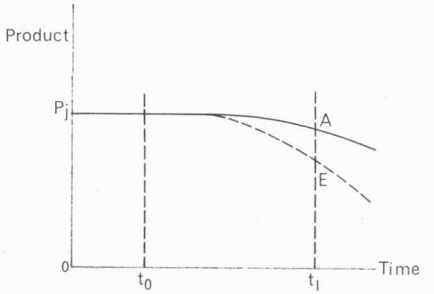
6. B. U. Ratchford, comments on a paper by H. S. Perloff, «Problems of Assessing Regional Economic Progress», *Regional Income: Studies in Income and Wealth,* 21, 1957, p. 67.

product j_i Expansion in the production of sector j is recommended to meet this demand. This situation is depicted in the diagram below:



The curve P_jE traces the production of sector j were it able to meet demand at time t_1 P_jA indicates actual production of the sector. AE represents the amount of production required over and above the present operating characteristics of sector j to meet demand. Thus, assuming it could adjust its operations to meet demand given the occurrence of an exogenous event, AE represents losses for j. This is an important point since this argument is not applicable to sectors which are either operating at capacity levels or are unable to adjust to changing conditions. In fact, sectors operating under adverse economic conditions for a prolonged period of time would become extinct. For the purposes of this paper the assumption is that sector j or region i can always improve. This assumption focusses attention to the measurement of losses.

Alternatively, the effect of an exogenous event reducing demand for product j_i is shown in the diagram below:



In this case, the line segment AE represents production over and above the level of demand satisfaction at time t_1. Unless storage or maintenance costs are zero this also represents loss.

The cases presented above, illustrate discrepancies between optimal and actual levels of economic achievement in a particular sector of a regional economy. The real world, however, is infinitely complex. Events influencing the output of sectors occur continuously through time and over space. Since optimality is unattainable only reduction of opportunity loss can be attempted. This should lead to more rational decision making and higher level of economic welfare for the population.

In summary, at the regional level, economic growth can be identified with changes in the demand for the products of the industrial sectors of that region. Institutional and technological innovations and shifts in market locations affect the demand for a product. As these innovations and shifts occur, demand changes and the economy is forced to adjust. Thus, to a large extent, the industrial composition of a region reflects its economic development over time. Given resources of the regional economy, a difference between the optimal and actual industrial composition is often encountered. This difference represents opportunity loss for the regional economy and reflects deficiencies in its economic structure that prevent it from attaining higher levels of welfare.

Clearly then, a worthwhile goal of economic growth policy at the regional level would be to reduce opportunity loss to a minimum. One of the ways to do this is to minimize the time it takes a regional economy to respond to institutional and technological changes. To achieve this, one would have to have the means of accurately and rapidly perceiving the occurrence of such changes. Technological and institutional changes, however, occur randomly. As noted above, if one is interested in the effects these changes have on a regional setting one has to recognize the interdependence of regional and national economic behavior. Addressing the problem of regional cycle analysis, Isard noted:

«...the regional investigator...is fully aware that national conditions bear heavily on regional developments...he is also aware that because nations are composed of regions, regional development programs and conditions can influence in part national fluctuations...»[7]

In general, if one is interested in the perception and measurement of the impact of institutional and technological changes, one should deal with them at the regional level but keep in mind that sectoral changes may be initiated at the national level.

To formalize the concepts put forth above, assume that a national economy can be expressed as a matrix. The rows i are the regions comprising the nation. The columns j represent industrial sectors.

7. W. Isard *et al., Methods of Regional Analysis: An Introduction to Regional Science,* The MIT Press, 1960, p. 184.

$$P = \begin{bmatrix} p_{11}\, p_{12}\, p_{13} \cdots\cdots p_{1j} \cdots\cdots p_{1m} \\ p_{21}\, p_{22} \cdots\cdots\cdots\cdots\cdots p_{2m} \\ p_{i1} \cdots\cdots p_{ij} \cdots\cdots p_{2m} \\ p_{n1}\, p_{n2} \cdots\cdots\cdots\cdots p_{nm} \end{bmatrix}$$

Each element of the matrix represents the production of sector j in region i. The sum of the row elements is the gross regional product; the sum of the elements in each column is the gross sectoral product. Thus,

$$P = \sum_{i=1}^{n} p_{i.} = \sum_{j=1}^{m} p_{.j} = \sum_{i=1}^{n}\sum_{j=1}^{n} p_{ij} \qquad (1)$$

There exists an optimal product P^o. The existence of such a product assumes perfect «factor utilization» and knowledge of consumer preferences, technology and institutional structures. Thus, P^o exists only in theory. Mathematically, it can be expressed as:

$$P^o = \sum_{i=1}^{n} p^o_{i.} = \sum_{j=1}^{m} p^o_{.j} = \sum_{i=1}^{n}\sum_{j=1}^{n} p^o_{ij} \qquad (2)$$

Similarly, actual product can be expressed as:

$$P^a = \sum_{i=1}^{n} p^a_{i.} = \sum_{j=1}^{m} p^a_{.j} = \sum_{i=1}^{n}\sum_{j=1}^{m} p^a_{ij} \qquad (3)$$

If the assumptions of perfect competition are met and the economy is a well-defined[8] system, P^a will equal P^o. In the real world, however, neither are these assumptions met nor are economies well-defined systems: Hence,

$$P^o \neq P^a \qquad (4)$$

It has already been determined that P^o is equal to the sum of the optimal sectoral products or the sum of the optimal regional products. Similarly, P^a consists of the sum of the actual sectoral products or the sum of the actual regional products. The inequality between actual and optimal product can be recast in several ways. A sector may not achieve optimality ($p^o_{.j} \neq p^a_{.j}$) due to disequilibria in resource reallocations caused by changes in technology or institutional frameworks. A region may not reach optimal production ($p^o_{i.} \neq p^a_{i.}$) as a result of demographic and cultural characteristics as well as resourse endowment, market locations and so on. Finally, a specific regional sector ($p^o_{ij} \neq p^a_{ij}$) may not attain optimal productivity. Therefore,

$$\sum_{i=1}^{n} p^o_{i.} \neq \sum_{i=1}^{n} p^a_{i.} \qquad (5)$$

$$\sum_{j=1}^{m} p^o_{.j} \neq \sum_{j=1}^{m} p^a_{.j} \qquad (6)$$

$$\sum_{i=1}^{n}\sum_{j=1}^{m} p^o_{ij} \neq \sum_{i=1}^{n}\sum_{j=1}^{m} p^a_{ij} \qquad (7)$$

These inequalities represent opportunity loss. Hence, it is possible to define:

1. Loss at the national level as $L = P^o - P^a$.
2. Loss at the sectoral level as $l_{.j} = p^o_{.j} - p^a_{.j}$
3. Loss at the regional level as $l_i = p^o_{i.} - p^a_{i.}$
4. Loss at the regional sectoral level as $l_{ij} = p^o_{ij} - p^a_{ij}$.

The left hand sides of these relationships can also be obtained by subtracting (3) from (2). Therefore,

$$L = \sum_{i=1}^{n} l_{i.} = \sum_{j=1}^{m} l_{.j} = \sum_{i=1}^{n}\sum_{j=1}^{m} l_{ij} \qquad (8)$$

$$l_{i.} = \sum_{i=1}^{m} l_{ij} \qquad (9)$$

The statement that gross national product can be —and frequently is—at a lower than optimum level because opportunities are not fully exploited in all regions in all sectors has been recast in mathematical notation. It should be emphasized that this formulation is correct in a strictly accounting sense, but does not contain any behavioral relationships.

The preceding discussion makes the estimation of optimal and actual production seem simple. In practice, any measurement attempt would require perfect knowledge of resource availability, the state of technology and the structure of the organizations involved. Furthermore, it would involve determination of optimum levels of resource use. To get around these requirements, one can replace the concept of optimal production with some reasonable substitute. Such a substitute could be the highest production level encountered in the nation. Alternatively, it could be some objective function determined by policy-makers and reflecting desirable and realistic production levels. Assuming it is the optimal and using it as a yardstick one can proceed.

Such a concept is familiar in planning. Economic base studies have employed a similar approach, that

8. Well-defined in this case means that no transactions cross its boundaries.

of minimum requirements.[9] An artificial economy can be constructed using minimum sectoral production levels as measured by employment, payrolls or other similar attributes observed within a set of similar in size economies. This fictitious economy serves as a standard against which the economies comprising the original set are compared. The assumption is that the minima observed serve local needs. Employment or payrolls over and above these minima represent the export or economic base of the economy. Clearly, this assertion can rarely be verified empirically because it is difficult to ascertain what percentage of the sectoral labor force is devoted to export production as opposed to production intended for local consumption. However, lacking a more precise and less problematic method for estimating income generation, the minimum requirements approach serves well as a substitute.[10]

The problem with concepts such as opportunity loss or economic base is that they tend to set economic performance standards that are either too high or too low since by definition extreme situations are chosen. To avoid this the analyst can select some other standard such as the average performance level of an economic unit over time or the average of a set of similar units at the same point in time. One such technique is the location quotient.[11] It is derived by expressing the relative presence or absence of the same attribute in a larger region containing the first one. Unfortunately, the use of a single set of standards tends to erase regional differences due to differential allocation of resources, geography and so on.

Given these difficulties, if one intends to develop a method that will enable decision makers to make more rational decisions on the allocation and utilization of resources he must develop acceptable standards for comparison and reference. To the extent possible, these standards must represent a level of economic performance attainable by the region under investigation. Additionally, it should adapt easily to fit the purposes of a wide spectrum of regional situations. It has been suggested that regions exhibiting optimal sectoral economic performance would costitute acceptable standards. It has also been noted, however, that these standards are untenable. The task, then is to modify them according to locational characteristics. To do this, a new quantity is introduced, p^e, representing the product that can be expected if a reasonably high level of resource allocation and use were attained.

The optimal product for sector j in region i can be expressed as the per worker production in sector j in the region with the highest performance, multiplied by the number of workers in sector j in region i,

$$p^o_{ij} = (p^a_{kj}/e_{kj})e_{ij} \qquad (10)$$

where k represents the region with the best performance.[12] Having expressed the optimal sectoral product in these terms one can return to the concept of expected product. If the reasoning used here is sound, the expected product of sector j in region i can be expressed as a function of a «location coefficient» τ and the optimal sectoral product for that region. Thus,

$$p^e_{ij} = f(\cdot, p^o_{ij}) \qquad (11)$$

More specifically,

$$p^e_{ij} = \tau p^o_{ij} \qquad (12)$$

Substituting, $(p^o_{kj}/e_{kj})e_{ij}$ for p^o_{ij} we have:

$$p^e_{ij} = \tau e_{ij}(p^a_{ij}/e_{kj}) \qquad (13)$$

The «location coefficient» varies from one industrial sector to another. It reflects the education and training of the labor force, industrial organization, quality and quantity of raw materials, supply and demand locations, consumption patterns and many other factors. Enumeration, let alone quantification, of all those factors would constitute a Herculean task. To overcome this obstacle, two substitute measures of variation are suggested, population and location. Information on both is readily available, easy to use and indicative of numerous cultural, economic and social phenomena. On one hand, similar population sizes reflect similarities in income. resource and product markets, productivity and specialization levels. On the other hand, location accounts for variations in climate, natural resources, infrastructure and other components of a region's profile.

The «location coefficient» can be thought of as a function of location and population. It is used to account for the portion of the difference between the region with the highest level of economic performance and the region under investigation that is due to locational characteristics. To do this a substitute for the region should be identical in all respects to the region under investigation. Since this is not possible, a similar region is acceptable.

The location coefficient consists of two ratios, each composed of two other ratios. The nominator of the first ratio expresses per worker production of sector j

9. For a thorough discussion of the method see E.L. Ullman, *et al., The Economic Base of American Cities,* U. of Washington Press, 1971.

10. Especially in view of the cumbersome data gathering and computational characteristics of the input-output method. For an authoritative discussion of interregional input-output see W. Isard, *et al.,* chapter 8, *op. cit.*

11. For a thorough review of the location quotient and other related techniques see W. Isard, *et al.,* chapters 5, 6, and 7, *op. cit.*

12. It should be noted again that this region can be real or fictitious.

in the substitute region s. The denominator represents per worker production in the region with the highest productivity k. The first ratio can be thought of as the per worker sectoral productivity location quotient. It can be expressed as:

$$p^a_{sj} e_{kj} / p^a_{kj} e_{sj} \qquad (14)$$

The nominator of the second ratio expresses employment in sector j in the substitute region as a percentage of the population of the substitute region. The second ratio is expressed as:

$$e_{sj} \kappa_i / e_{ij} \kappa_s \qquad (14.5)$$

Underlying the second term is the assumption that the ratio of employment to total population in a region reflects the perception of the economic strengths and weaknesses of the region by its inhabitants. To the extent, therefore, that the inhabitants of a region are rational, it can be said to reflect an appropriate and possibly optimal allocation of the labor force.

The location coefficient can now be expressed as:

$$\tau = (e_{kj} / p^a_{kj}) (\kappa_i / e_{ij}) (p^a_{sj} / \kappa_s) \qquad (15)$$

The third term on the right hand side of (15) expresses per capita production of sector j in the substitute region. The first term, formulated as the ratio of the labor force in sector j over the actual production of that sector, is a coefficient reflecting the state of technology in the region with the highest performance. Thus, these two ratios express expected per worker production of sector j suitable for the substitute region, assuming that it operates under optimal technological conditions. The second ratio is a multiplier, the function of which is to make τ sensitive to the impact of the size of the labor force in sector j in the ith region. Thus, an increase in the number of workers in sector j in the region under investigation, will reduce the value of τ *ceteris paribus.* The rationale behind this term is that the greater the number of people employed in sector j in relation to the population, the higher the likelihood that this sector is approaching saturation levels in terms of employment.

The range of values of the location coefficient encompasses all real non-negative numbers including infinity. Values of zero for a sector could imply that its product in the substitute region is zero, sectoral employment in the region with the highest performance is zero or finally that the region under investigation is uninhabited. Therefore, while theoretically tenable, values of zero are in reality absurd. At the other extreme, values of plus infinity could mean that the product of the highest performance region in the sector in question is zero, that there is no suitable substitute region or that this sector is non-existent in the region of interest. Stated differently, if τ is equal to $+\infty$ there is no criterion of adjustment for locational characteristics. Thus, a more likely range of values for τ would be $0 < \tau < < +\infty$. Substituting the value of τ in (13):

$$p^e_{ij} = e_{ij} (p^a_{kj} / e_{kj}) [(p^a_{sj} / \kappa_s) (e_{kj} / p^a_{kj}) (\kappa_i / e_{ij})] = (p^a_{sj} / \kappa_s) \kappa_i \qquad (16)$$

The expected product of sector j in region i is expressed as a function of its population and the per worker actual production of sector j in an appropriately selected substitute region. The process of selection of this region is important since it will determine the success or failure of a particular analytical effort in this area.

The criteria used to select a substitute region must be rigorous, must have conceptual validity and exhibit a high degree of replicability to allow for independent verification. The substitute region should be similar to the subject region both in terms of physical and socioeconomic characteristics. Specifically, it should have the same type of climate, size and similar geological and physical features at approximately comparable locations. The areas surrounding the two regions as well as their locational relationships to other urban centers should also be roughly the same. Population size and density, ratio of urban to rural population should be comparable. The existence of one or more urban centers within the subject region as well as the relationship of such centers to their hinterland should be replicated in the substitute region. Finally, the infrastructural characteristics of the two regions, especially those related to transportation, should be comparable in scope, size and relation to one another. Even if all of the above criteria are met, however, it is doubtful that total replicability can be achieved.[13]

Value judgements will often cause pertinent regional components to be included or excluded from consideration regarding the substitute region by different analysts. Thus, allowances for variation will have to be made, both in terms of the size of the region chosen and characteristics to be included or excluded. After all, at times, decisions cannot be deferred until better methods or more data are available. Unfortunately, as evidenced in the paragraphs that follow this was the case with Greek data.

To test the validity of the methodology proposed here, manufacturing production and employment data for Greece and the Greater Athens Region (GAR) were obtained for 1969 and 1973. Population figures for the country and the GAR for the

13. Spectral analysis techniques may be used to discover the substitute regional. For a thorough discussion of these techniques and some of their applications see J.N. Rayner, *Introduction of Spectral Analysis,* Pion Limited, 1971, especially chapter 9.

TABLE 1. *Locational Adjustment Coefficients and Actual versus Expected Production by Major Manufacturing Sector for the Greater Athens Region: 1969 and 1973*

Industry	SIC Code	τ		P^a_{ij} in 000's of drachmas		p^e_{ij}		p^e_{ij}/p^a_{ij}	
		1969	1973	1969	1973	1969	1973	1969	1973
Food	20	.983	1.150	5189189	8426447	3823028.80	8085505.00	.74	.95
Beverages	21	.541	.713	1505779	2753795	656273.44	1957877.40	.43	.71
Tobacco	22	.839	.792	1499409	1801230	1154133.80	1572383.03	.77	.87
Textiles	23	.319	.444	6562053	12261931	2013457.90	6154938.40	.31	.50
Clothing & Footwear	24	.165	.259	1984294	4270807	204487.20	882244.74	.10	.21
Wood & Cork	25	.887	1.087	474727	8768530	374362.26	1347793.30	.78	1.53
Furniture	26	.673	.300	622978	1075010	101925.09	283184.40	.16	.26
Paper	27	5.405	.329	1202482	2209413	469201.76	832881.20	.39	.38
Printing & Publishing	28	.405	.044	1488136	2907883	73240.61	114668.28	.05	.04
Leather	29	3.810	.994	333408	544728	256072.96	428142.65	.76	.78
Rubber & Plastic Products	30	.119	.208	2045107	3583069	243251.79	739188.67	.12	.21
Chemicals	31	.231	.323	3435641	5919487	951463.62	2556855.90	.28	.43
Products of Petroleum & Coal	32	.402	1.002	204786	344408	533302.52	3862656.20	2.60	11.21
Non-Metallic Mineral Products	33	.813	.933	1613379	2435715	1431582.96	2699296.10	.89	1.11
Basic Metal Industries	34	1.902	2.797	117496	1675864	2406925.80	5353877.80	20.48	3.19
Metal Products	35	.288	.564	2770933	3912737	606857.13	2665503.20	.22	.68
Machinery (Non-Electrical)	36	.274	.343	1060836	1907801	803620.92	654410.81	.76	.34
Electrical Supplies	37	.077	.208	3675884	7509320	243802.54	1666005.70	.07	.22
Transport Equipment	38	.054	.182	2226797	5133726	75184.67	708853.67	.03	.14
Total	20-39*	.454	.517	38313328	70364212	16862728.00	42607190.00	.44	.60

*39 is the residual which is labeled «Miscellaneous». It appears to be the equivalent of the US SIC Code «Other Industries».

same years were also procured. In contrast to sectoral employment information which is available by region, sectoral production data are reported only for the GAR and the entire country. Given this limitation and time constraints it was decided to use the entire nation as the region exhibiting optimal production patterns and to compare its performance with that of the GAR.[14]

The choice of suitable substitute region became problematic for the same reasons. After considerable deliberation, it became apparent that the only viable alternative was to obtain the difference between the entire country and the GAR for each sector and to designate «the rest of Greece» as the substitute region. Obviously, this decision violates important assumptions of the model, namely those that establish the criteria for selecting a substitute region. Violation of these assumptions appeared to be a fair price to have to pay to apply the methodology. The results of this application which appear and are discussed below suggest that this decision may not have been without foundation.

Having established an «optimal» and «substitute» region the data were fitted to equations (13) and (16). From these, locational adjustment coefficients and expected product for each sector for 1969 and 1973 were obtained. To compare expected and actual sectoral product the ratio p^e_{ij}/p^i_{ij} was calculated for each sector j. This quantity can be thought of as the coefficient which if multiplied by the actual sectoral product would reduce opportunity loss to zero.

Based on the results appearing in Table 1, it is reasonable to argue that during the 1969-1973 period there has been a notable diffusion of economic opportunities in Greece. Stated differently, the economic preponderance of the GAR vis-à-vis the rest of the country decreased. The regionalization of economic opportunities away from the GAR did not affect all sectors equally. It appears that capital intensive, durable goods sectors exhibit higher resis-

14. For a similar approach to the assignment of normative characteristics to a region see: D.J. Plessas and E.S. Carpenter, «Empirical Designation of Health Service Areas», *Health Services Research,* 10: Winter, 1975, pp. 333-348.

tance to regionalization than other sectors. For example, sectors 27, 28 and 29 remained stable with the first two still highly concentrated in the GAR. «Basic metal industries» and «non-electrical machinery» have concentrated further while «products of petroleum and coal» remained thinly concentrated in the GAR at levels well below its theoretical share. The latter probably reflects the fact that the ratio of managerial and office personnel to production workers is high—approximately five to one. Moreover, it seems that this sector's administrative functions are localized in the GAR with the production workers scattered in other regions.

Several hypotheses can be advanced to explain the shift of economic opportunities in Greece. Unfortunately, these are not testable within the present analytical framework. Two, however, are worth noting: First, rapidly rising social costs due to environmental pollution, congestion and crowding, industrial land shortage and lack of space for amenities and housing are factors that increasingly influence managerial decisions concerning new plant location. Second, the measures aimed at the spatial dispersal of industry which culminated in a series of legislative decrees from about 1952 to 1967 have effectively contributed to the locational shifts suggested here.[15] Though not mutually exclusive, these two hypotheses are disjointed to a certain degree both developmentally and historically. That is, the deterioration of the quality of life in the GAR occurred after the industrial decentralization schemes had run their full course. Essentially, this means that the shift demonstrated in this paper is either spent momentum of the decentralization schemes—the diminished ripples of the initial thrust—or conversely the initial ripples reflecting the growing environmental problems in the GAR.[16]

A full assessment of environmental pollution in the GAR is not possible at this point since no information is gathered on a systematic, on-going basis concerning important environmental indicators. Fragmentary evidence suggests that per capita exposure to air pollutants is anywhere between 400 to 600 pounds per year.[17] Data on water and noise pollution in the Athens area are available from the joint Ministry of Social Services-World Health Organization project. As noted, the GAR is highly congested, crowding 35 percent of the nation's population to 0.3 percent of its area and rapidly converting its last vestiges of open space to residential and industrial uses. Little attention has or is being devoted to the region's ecological carrying capacity. It is likely that congestion and the high levels of contamination of the region's air and water resources are linked to significant public health effects manifested in the rapid increase of accidents and respiratory, infectious and parasitic illness as the major causes of disability and death within the GAR. It is equally likely that industrial location/relocation decisions are becoming more sensitive to these factors.

The second hypothesis provides another feasible explanation of the shifts demonstrated in this paper in spite of the fact that the effectiveness of Greek decentralization policies has not been rated very highly.[18] The substance of these policies is summarized in Table 2. Starting in 1952 the program consisted entirely of a system of indirect subsidies in the form of tax credits, depreciation allowances, tariff reductions and employer contribution reductions to various social security, pension and worker funds. These measures failed to specify the direction «decentralized» growth ought to take or to establish a truly spatially graduated system of subsidies whereby benefits increase proportionately with distance from the capital. Essentially, manufacturing firms were considered «provincial» if they located further than 25 to 30 miles from downtown Athens. Moreover, the programs' complicated but liberal subsidies provided few incentives for firms to locate beyond the 30 mile limit. As a result, most firms located just beyond this limit at a cost of 50 billion drachmas in lost revenues for the period between 1959 and 1966.[19] Parenthetically, this figure is equal to about 45 percent of the net national product for 1964!! The above suggests a massive failure of decentralization efforts.

In retrospect, a rigorous test of the decentralization hypotheses may not shed any light on the important policy issue of egalitarian distribution of

15. A report published in 1940 titled *The Problem of the Industrial Concentration in Greece* by the Supreme Economic Council provided the impetus for the post World War II decentralization efforts in Greece.

16. Greek government planners, particularly those in the regional planning section of the Ministry of Coordination, should explore this problem further for its obvious implications to regional development policy.

17. See D.J. Plessas, «Air Pollution Inventory of the Greater Athens Area», *Economikos Tachydromos,* 1182, Dec. 30, 1976. Estimates of the social costs of air pollution and industrial injuries will appear in a research monograph by the same author titled «The Social Costs of Environmental Pollution in the Greater Athens Area».

18. For a critical analysis of this phase of Greek regional policy see D.J. Plessas, *The Decentralization Aspect of European Regional Policy and Development with Special Reference to Greece,* Chapter III, University Microfilms, Ann Arbor, 1969. Also B. Ward, *Greek Regional Development,* Center of Planning and Economic Research, Athens, 1963 and *The Effectiveness of the Tax Incentives in Greece* and *Some Proposals for Their Improvement,* Center of Planning and Economic Research, Athens, 1967.

19. *The Effectiveness of the Tax Incentives in Greece* and *Some Proposals for Their Improvement,* Center of Planning and Economic Research, Athens, 1967.

TABLE 2. *Synoptic Structure of Decentralization Schemes. 1952-67*

Legislative Decree	Geographic Differentiation of Subsidies	
	Beyond Province of Attica	30 Miles beyond the Province of Attica
2176/1952	1. Local taxes abolished 2. 6 percent tax on wages and salaries abolished 3. Depreciation rate doubled 4. 25 percent credit on tax free reserves 5. Sales taxes reduced by 20 percent 6. Tariffs reduced by 50 percent	1. 2. 3. 4. } Same 5. Sales taxes reduced by 30 percent 6. Tariffs abolished
3213/1955	1. All of the above, plus... 2. 20 percent reduction in social security contributions 3. 40 percent reduction of tax on profits intended for reinvestment	1. 2. 3. } Same
3765/1957	Same as above	Same as above
4002/1959	1. All of the above, except... 2. Tax credit on profits intended for reinvestment reduced by 50 percent for all firms regardless of location	1. Same 2. Tax credit on profits intended for reinvestment raised to 60 percent for a net gain of 10 percent. Island locations enjoyed a 40 percent net reduction
147/1976	1. All of the above, except... 2. Several «growth poles» are exempted from the fast depreciation clauses	1. Same 2. Same

economic opportunities in Greece. In fact, it may be argued that even for the 1969-1973 period economic opportunity must have concentrated in the GAR at a large enough scale to have offset further accumulation of industrial activity at the GAR' s periphery.

Given the nature of the methodology and the motivation for undertaking its application, it is felt that its validity lies in its capacity to assist in policy formulation. To apply it, modifications may be necessary. These modifications are dictated by disparities between the real world and abstractions of it. It was pointed out, for example, that the difficulties of including all or even most of the factors influencing economic performance in the model are insurmountable. Hence, what were judged to constitute reasonable substitutes were used.

Unfortunately, similar to the discrepancy between the real world and models of it there exists another, perhaps more treacherous disparity between models and data necessary for their function. Like models, data are substitutes for the real world and as such, lack perfect correspondence to it. As an example, consider the data for industrial sectors. They are available at various levels of aggregation for various spatial economic systems. Frequently, however, the level of aggregation is not consistent among them. Consequently, any analytical effort is limited unless the analyst has the time and money to gather his own data. A second problem is encountered when data for a particular industry or region are partially or totally unavailable, a surprising but not infrequent event as obviated by the application above.

Perhaps the most serious problem lies in the correspondence of industrial classification schemes to

sectors. The standard industrial classification schemes used in the majority of industrial structure studies is antiquated and can thus be misleading. Relatively recent trends in technology and administrative practice have made corporate giants common. These multisectoral industrial organizations consist of many diverse sub-organizations and do not conform to the classification schemes used until now. It is, therefore, difficult to determine which sectors the production of such corporations should be assigned to. Related to the problem of the corporate giant is the issue of consumption. Some industries are geared for the production of goods or services directly available to the consumer. The output of others is consumed exclusively by other sectors. Thus, while the notion of production is conceptually attractive, it is difficult to define empirically.

In summary, there exist opportunities which are not taken advantage of, because they are not perceived. In terms of economic development, courses of action can be described as exploiting existing opportunities or creating new ones. Both involve the removal of obstacles to change. All else being equal it is easier to exploit them. As defined, the concept of opportunity loss is *ex post.* In real world applications it is used in an *ex ante* sense. Within the framework of such applications forecasting future economic deficiencies is based on past deficiencies. Therefore, the diagnosis of deficiencies depends on the availability and quality of information on past trends. Thus, methods used to measure opportunity loss should be used with caution since policy formulation disagreements arise mainly over the assessment of past trends.

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